ANNUAL REPORT FOR THE KLAMATH NETWORK INVENTORY & MONITORING PROGRAM: FY 2003 RARE PLANT INVENTORY

Prepared by

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EXECUTIVE SUMMARY

In its inventory study plan (Acker et al. 2001) the Klamath Network outlined two overarching goals for its inventory program: (1) to document 90% of the vascular plant and vertebrate species believed to occur in each park; and (2) to determine the distribution and abundance of species of special concern in each park. The network recognized rare plants as a group of taxa of special concern and basic information in the population size(s), vigor, and population dynamics were deemed essential to effectively manage rare and sensitive plant populations.

Prior to field inventory, we reviewed existing park lists, on-line databases, reports, student theses, and other documentation to develop a target list of potential rare species for inventory in each park. Field inventories were then conducted using three general survey approaches: ***(1) Targeted surveys*** to provide the most information for the time expended in localized habitats believed to harbor distinctive species, such as springs, rocky outcrops, and small meadow openings*; **(2) Revisits of historic populations*** using a targeted survey of the historic population area*; **(3) Quantitative belt samples*** to provide an unbiased sample of the habitat and to provide the opportunity for analyzing distribution and abundance of rare species within the habitat. Klamath Network staff met with park botanists to decide which inventory techniques would be employed in each park

We used the following protocols when a rare plant was encountered: **1)** we collected a voucher specimen if the population size was deemed healthy and stable (>20 individuals); **2)** we georeferenced the location of the population; **3)** we recorded digital images of the plant and its habitat; **4)** we completed a Klamath Network Rare Plant Site Information form (Appendix 1) and a Rare Plant Mapping form (Appendix 2).

Inventory Results by Park:

Whiskeytown National Recreation Area: We focused on relocating sites of historic plant populations and collecting current data on species presence and abundance. Rare plants were found at some but not all of the existing historic sites in the park. We recorded populations of *Allium sanbornii* var. *sanbornii*, *Trillium ovatum* ssp. *oettingeri*, *Sambucus mexicana* and *Arnica venosa.* The *Arnica venosa* population was more extensive than previously recorded, suggesting the population may be expanding.

Lava Beds National Park: We implemented quantitative belt samples in various habitats within the monument, along with targeted surveys. Neither survey type located any rare plant species or new taxa for the monument. Future inventories focusing on unique microhabitats (lava flows, lava tube mouths) may be the most fruitful for locating unrecorded rare species.

Redwood National Park: The park botany staff desired surveys of two recently acquired and undersampled areas in the northern part of the park: (1) the Little Bald Hills (LBH) land acquisition and (2) the Tracy Property. Both of these areas have high potential for rare species. We used both targeted searches and quantitative belt samples to maximize information gained. Rare plants found at the Little Bald Hills site included *Sanicula peckiana*, *Calystegia atriplicifolia* ssp. *buttensis*, *Perideridia gairdneri*, *Iris innominata*, *Iris tenax* ssp. *klamathensis* (may have been misidentified in field, specimen not collected), *Senecio bolanderi* var. *bolanderi*, *Arnica spathulata*, and *Horkelia sericata.* Rare plants found on the Tracy Property included *Arnica spathulata*, *Castilleja miniata* var. *elata*, *Coptis laciniata*, *Iris innominata*, *Senecio bolanderi* var. *bolanderi*, *Calystegia atriplicifolia* ssp. *buttensis*, *Veratrum insolitum*, *Pityopus californicus* and *Lillium bolanderi.* For future inventories in these two locations, we recommend more targeted searches in wetland and rocky outcrop habitats.

Oregon Caves National Monument: Park staff desired inventories in target habitats to detect new populations of species known to occur within the park as well as any previously undetected taxa. The targeted surveys focused on riparian areas and shale/granite outcrops. Two species were observed that were new to the park, *Cardamine nuttalli* var. *covilleana* in the riparian zone of Upper Cave Creek and *Linanthus ciliatus* on a south-facing granite outcrop near the south/southwest park boundary.

Lassen Volcanic National Park: After consultation with park staff, wetland and aquatic environments were highlighted as under-sampled habitats and a park priority for botanical inventory. At LAVO we visited 20 lakes and ponds that had been determined by the park botanist to contain potential aquatic plant habitat (littoral emergent vegetation) through aerial photography. New species resulting from the survey included *Rhynchospora alba* and *Carex aquatilus* var. *aquatilus.* The latter species was observed in the east meadow of Horseshoe Lake, near the ranger cabin. Horseshoe Lake was determined to be a site with high potential for rare plant species and a potential focal point of future inventories. A second survey conducted by park staff in late August recorded another new species to the park, *Sisyrinchium elmeri*, in a seep area in the Grassy Swale.

Crater Lake National Park: After consultation with park staff, two main habitats were selected for survey: pumice slopes near the caldera rim and midelevation seeps, springs, and riparian areas. In the pumice zones, target species were *Botrychium pumicola* and *Arabis suffrutescens var. horizontalis.* In wet environments the target species were *Mimulus jepsonii* and *Collomia mazama*. Three known rare species were located, *Collomia mazama*, *Carex simulata*, and *Carex crawfordii. Collomia mazama* was found in bloom at a known site, Dutton Creek/PCT, southwest of the rim. At this site, a rare bryophyte, *Schistostega pennata*, was also found. This is the southernmost population of the species in the Cascades. At the Sphagnum bog, *Drosera* x *obovata* was found; this rare species is new to the park list.

INTRODUCTION

In its inventory study plan (Acker et al. 2001), the Klamath Network stated two overarching goals of its inventory program: (1) to document 90% of the vascular plant and vertebrate species believed to occur in each park; (2) to determine the distribution and abundance of species of special concern in each park. The network recognized rare plants as a taxon group of special concern. In 2003, field inventories were designed to address both the network's goals by gathering information on new species or rare plant populations, and, where feasible, using quantitative samples to determine the distribution and abundance of rare plant species in the parks.

This report describes an integrated rare plant inventory conducted in the Klamath Network parks in Fiscal Year 2003. Actual fieldwork occurred in spring and summer 2003. The inventory used several methods for detecting species or populations in the network parks. Extensive inventories of widespread habitats were employed in conjunction with more intensive inventories of target habitats and reconnaissance of historic population sites. In all cases, I&M field inventories were designed to complement past and present fieldwork within each park.

BACKGROUND

The Klamath Region is noted for rare and locally endemic plant species of both ancient and recent evolutionary origin (Whittaker 1961, Stebbins and Major 1965, Smith and Sawyer 1988). These species are often poor competitors with widespread native and non-native plant species and often occur in areas where competition is limited by unique local conditions of hydrogeology, substrate fertility, or disturbance (Coleman and Kruckeberg 1999). For example, the entire global range of *Puccinellia howellii* is a mesosaline seep area in Whiskeytown National Recreation Area (WHIS). *Collomia mazama* is associated with meadow margins in and around Crater Lake National Park (CRLA), as is *Trillium ovatum* ssp. *oettingeri* in WHIS. Several rare graminoids in Lassen Volcanic National Park (LAVO) area are found only in floating bog environments. Still other rare plant species are more widely distributed in natural communities, but maintain low densities and reproductive rates (e.g., *Cypripedium fasciculatum).* The factors limiting the distribution and abundance are many and varied, but in all cases extinction risk is believed to be relatively high for rare species. Park managers are concerned that anthropogenic effects, ranging from direct effects of roads, fire management, or campground traffic, or synoptic environmental change (e.g., climate change, pollution, altered disturbance regimes) may threaten rare plants in the park. Consequently, basic information about the rare plant population size(s),

vigor, and population dynamics is needed to effectively manage rare and sensitive plant populations.

Aquatic environments have yet to be comprehensively surveyed in most of the Klamath Network parks and have been recognized as habitat likely to harbor new species in several parks. Aquatic plants pose special problems for identification because they require special sampling approaches and they have unique morphological characteristics that make them taxonomically challenging for non specialists. Aquatic plants are believed to especially sensitive to water-borne pollutants and other changes in the aquatic environment, such as non-native plant invasions. At present, little is known about the diversity or status of aquatic vegetation in the Klamath Network parks.

Since the habitat affinities and potential threats to rare and aquatic plant species are often highly idiosyncratic, a multifaceted inventory approach is needed that allows flexibility in use of time and resources. This inventory sought to simultaneously locate new plant species in each park, to locate new populations of known species, and/or to relocate historic rare plant populations. In several parks, we also surveyed aquatic environments. Where possible, we also provide information to better characterize rare plant habitat as well as potential threats to these species.

METHODS

Prior to field inventory, we reviewed existing park lists, on-line databases, reports, student theses, and other documentation to develop a target list of potential rare species for inventory in each park. To devise rare plant lists for each park, we queried existing on-line databases for information about rare plants known to be in the area. For the California parks, we consulted the California Native Plant Society's website (www.cnps.org) and the California Natural Diversity Database (www.dfg.ca.ca.gov/whdab). For the Oregon parks, we consulted the Oregon Natural Heritage Program (www.oregonflora.org/ofn/v4n1/heritage_lists.htm). To determine rarity, we either consulted directly with park botanists or noted species from the two databases above that had the potential to occur in a park. We also recorded species that were not necessarily rare regionally, but were determined by park staff to be rare or expected, but not yet recorded, in the park. Field inventories were focused to address obvious gaps or sampling biases noted in the review of the park species list. We then refined our inventory plans in consultation with botanists and/or other natural resource staff in each park. In some cases, the park botanists outlined a specific area or habitat for inventory. In other cases, we sampled more broadly across park habitats. Inventories were prioritized to target specific taxa for which documentation was lacking or where there was strong reason to believe that a species was imperiled.

Basic Survey Approaches

Our field inventories employed three major approaches:
(1) Targeted surveys; (2) Revisit of historic populations; (3) Quantitative belt samples.

Targeted surveys were used to provide the most information for the time expended in localized habitats believed to harbor distinctive species, such as springs, rocky outcrops, and small meadow openings. In these habitats, field botanists thoroughly searched the area for rare plant species. Time spent surveying a target habitat was based on how much time the crew had on a particular day as well as size, accessibility, and diversity of the habitat. Where a thorough

reconnaissance was logistically unfeasible, we recorded the time spent searching in each habitat. If an area held a high potential for rare plant species and a thorough search could not be performed, due to night fall or other circumstances, the crew would return at the next available opportunity to complete the survey

While performing a targeted survey, we conducted the following activities upon encountering any suspected rare species: 1) we collected a voucher specimen if the population size was deemed healthy and stable (>20 individuals); 2) we georeferenced the location of the population. For a compact population (i.e. subpopulations less than 30 m apart), we recorded a single waypoint using a hand-held Global Positioning (GPS) unit; if the population was dispersed, multiple waypoints were taken around the population perimeter. Later in the field season, GPS track mode was implemented on a limited basis. GPS Track mode allows for the delineation of a rare plant population (i.e., a population's perimeter can be traced). Track mode expedites the mapping of a population in the field and in GIS, by eliminating the need to take multiple waypoints and to later connect those waypoints in GIS to make a polygon. 3) we recorded digital images of the plant and its habitat. 4) we completed a Klamath Network Rare Plant Site Information form (Appendix 1) and Rare Plant Mapping form (Appendix 2).

For species we suspected to be rare but which we could not definitively identify in the field, we recorded a waypoint and digital image(s). A voucher specimen was also collected if, as above, the population was deemed sufficiently large (> 20 individuals) and stable. All unknown specimens were either subsequently identified by the field crews or taken to an expert (i.e. park botanist or local authority) for verification.

Re-visitation of known rare plant populations was employed, upon request, at parks with known populations of rare vascular plants. Field crews obtained maps of historical populations from park staff and revisited the general site, typically the specific population area and the immediate surroundings, using and conducted a targeted survey of the area containing the plant population.

Quantitative belt samples were used in more extensive habitats where a thorough survey was logistically unfeasible. The goal was to provide an unbiased sample of the habitat and to provide the opportunity for analyzing distribution and abundance of rare species within the habitat.

All sampling was conducted from a baseline transect and the quantitative belt plots were arrayed perpendicular to the baseline. All transects and belts were located within the focal habitat area, typically a large continuous habitat type (e.g., Jeffrey pine woodland), by placing the transect baseline along the long axis of the habitat type, with sampling belts arranged perpendicular to and systematically along the baseline (Figure 1). The botanist would select the azimuth of the baseline transect, establish perpendicular transects, and set sampling belt lengths (belt width was always 10 m) to maximize coverage of the habitat. Interbelt distances along the baseline were determined by dividing the baseline by the number of potential samples feasible in the allotted time.

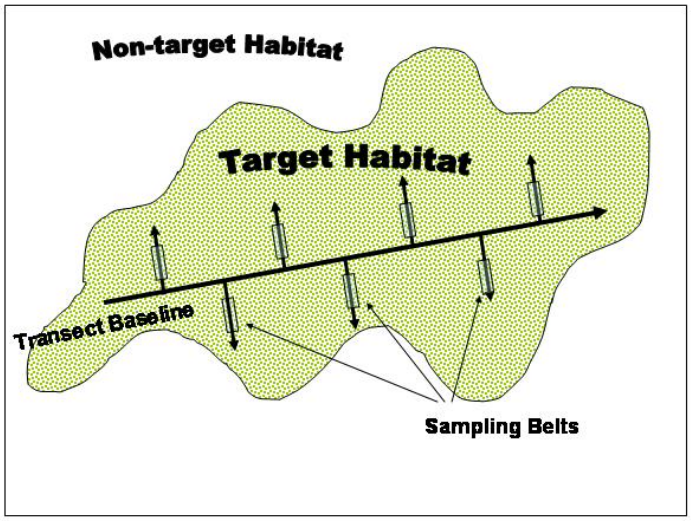

Figure 1. A schematic illustrating how quantitative belt samples were arrayed. The transect baseline bisects the habitat and the sampling belts run perpendicular to the transect baseline.

After selecting the interbelt distance and the belt length, random start distances were generated for the starting point of the systematic perpendicular transects along the baseline transect. Placement of each sampling belt along the perpendicular transect was determined by selecting a random number constrained to be equal to or less than the interbelt distance. In most cases, interbelt distances were 100 to 200 meters. In a similar way, sampling belt placement was determined to be a random number up to the length of the belt (typically 100 to 200 m). In each case, two numbers were selected from the random number table, and the absolute value of the difference between the numbers became the random start distance. For instance, where the distance between belts was 200m, the random starting distance of the transect from the original chosen spot was always <= 200m.

At each sampling belt, we completed a site information form (Appendix 1), recorded a GPS waypoint, and took a digital photograph(s) at the beginning of the belt, unless otherwise noted on the site information form. A Rare Plant Species Transect form (Appendix 3) was also completed for each quantitative belt.

When a rare plant species was encountered in a belt, we used the same documentation techniques described above for the targeted searches. Because Transect/Belts were often established in homogeneous habitats, full documentation was not recorded for each subpopulation if multiple populations existed. A new form was completed if notable differences in the two populations were found; this was done at the discretion of the field botanists. However, site information was collected for each sampling belt.

Park-Specific Inventories

The general inventory techniques described above were used in various combinations in each of the six parks, depending upon the type and extent of the rare plant habitat sampled, the time available, past inventory effort, and goals developed with park botanists.

Whiskeytown National Recreation Area

After consultation with park staff, re-location and current documentation/data on historic known sites of rare plant populations were determined to be the highest priority. Rare species known to exist within the park are: *Allium sanbornii var. sanbornii, Allium tribracteatum, Arnica venosa, Clarkia mildrediae, Clarkia virgata, Cypripedium fasciculatum, Eleocharis parvula, Navarretia heterandra, Penstemon purpusii, Puccinellia howelii, Sagittaria sanfordii, Sedum paradisum, Trillium ovatum ssp. oettingeri, Triteleia crocea var. crocea, Piperia unalascensis, Sambucus mexicana.* Known localities for a number of these species had not been revisited recently and documentation of their status was needed.

Based on analysis of the park's vascular plant list and species notes compiled by Gretchen Ring, WHIS Botanist, and observations of habitat features of known rare plant localities, species-specific surveys were also performed. These surveys were concentrated in areas of likely habitat for the target species. Habitat-specific surveys were also performed in unique habitats of the park thought to have a high potential for unique plant species, such as blue oak woodland, low-elevation mixed oak woodland (around Clear Creek), and higher elevation riparian and forest habitats (around Coggins Park and Shasta Bally).

Our field inventory comprised two field visits: (1) the first field inventory session lasted for three weeks, from 4/28 - 5/14/03. This session focused on low elevation habitats in the park. The second session (7/7- 7/10/03) focused on the higher elevation sites in Coggin's Park and on Shasta Bally.

Lava Beds National Monument

After consultation with park staff, it was decided that both the targeted survey and transect/belt survey methods would be carried out in various habitats within the monument Table 1.). The field inventory lasted from 5/19- 6/5/03. Six transects were established in habitats that comprised several hectares or more in the park. We did not sample open lava flows. Key habitats were delineated by joint analysis of soil type maps and the plant communities recognized in Dean Erhard's thesis, *"Plant Communities and Habitat Types of Lava Beds National Monument" (Erhard 1979).* For convenience, habitat types are described below using the superficial vegetation type names. Other pre-field inventory references used included the parks comprehensive list, "Plants of Lava Beds", a list of historic/known sites for all documented vascular plant species, and a list of potential rare plants we generated from the California Natural Diversity Database (CNDD). The plant list in Erhard (1979) indicates the presence of one rare species at LABE: *Penstemon cinereus*. The Jepson Manual treats *P. cinereus* as *P. humilis var. humilis*, which isn't a rare species. However, in California Native Plant Society's Inventory of Rare and Endangered Plants of California *P. cinereus* is a list 4 species. The habitat type of *P. cinereus* is Great Basin scrub, pinyon and juniper woodland with volcanic, sandy, rocky substrate. Its elevation range is 730-2200 meters; blooming time is June-August.

Table 1. Number of transects established in each habitat type, along with belt number and dimensions.

HABITAT TYPE (Transect #)	NUMBEROF BELTS	BELT LENGTH	INTERBELT INTERVAL
Cheatgrass/sage(2)	2x5	200m	200m
Bunchgrass/sage(1)	6	200m	300m
Cheatgrass/bunchgrass/rabbitbrush(1)	6	200m	300m
Mountain mahogany/ pine(1)	6	200m	300m
Bunchgrass/juniper(1)	6	200m	300m

In addition to the quantitative belt sampling, targeted surveys were carried out in smaller, local habitats such as the Caldwell Cave collapse and the northwest escarpment in the park.

Redwood National Park

In Redwood, park staff desired a survey of two small, recently acquired areas in the northern part of the park: (1) the main habitats within the Little Bald Hills (LBH) land acquisition and (2) the Tracy Property. Park staff determined these sites to be under-sampled habitats with a high potential for rare plant species. Prior to field inventory, we reviewed several lists of potential rare plants complied by NPS staff, Jedediah Smith State Park, CNPS, and the CNDD (California Natural Diversity Database). The field inventory session in REDW occurred from 6/2 -6/19/03. Given the remoteness of the sites, and rugged, brushy terrain, it was determined to be impossible to thoroughly census all the areas in the time available. Therefore, we used several survey techniques to maximize information gained.

In the Little Bald Hills, we used the Little Bald Hills trail as a baseline for quantitative belt samples. It naturally bisected a large portion of the habitat, allowing use of the quantitative belt sample method. We established a total of 20 belts: thirteen 200 meter-long belts each 50 meters apart and seven 100m long belts each 200m apart. Length of the seven sample belts was shortened (to 100m from 200m) halfway through the inventory to make sure sampling belts stayed within the target habitat, which became narrower at its eastern end. Targeted surveys were carried out in other parts of the habitat that weren't conducive to belt sampling because of their location, size, topography, or due to their scarcity wouldn't have been represented in many belts, if any. Since the Little Bald Hills has a high concentration of serpentinite bedrock, which is ideal habitat for many rare plants, we focused on rocky outcrops for thorough survey.

At the Tracy Property, we established one transect and sampled nine 100 m belts each 100 meters apart on the western half of the property. Targeted surveys were also carried out on the Tracy Property in the small Jeffrey Pine grove and in open areas along the trail that bisects (runs east-west) through the property. The Tracy property is much smaller and easier to access than the Little Bald Hills; to maximize efficiency we surveyed the Tracy Property on our travel days at the beginning and ending of each field tour.

Oregon Caves National Monument

In Oregon Caves, the primary objectives of the park staff were to implement field surveys that emphasized detecting new populations of species known to occur within the park as well as occurrences of taxa previously undetected yet likely to occur. Our references included a list of potential rare plants from the Oregon Natural Heritage Program and an existing comprehensive plant list for the park. From 6/23 - 6/26/03, the crew performed only targeted surveys. John Roth, ORCA Natural Resources Chief, determined the target habitats, based on under-sampled areas and relative plant diversity. The habitats included- (1) riparian areas and (2) rocky outcrops (including unique shale and granite outcrop areas).

Lassen Volcanic National Park

After consultation with park staff, wetland and aquatic environments were highlighted as under-sampled habitats and a park priority for botanical inventory. Since many of the rare plants in LAVO are in the Cyperaceae, and very difficult for seasonal staff to identify, field crews attended a training on Cyperaceae identification taught by Lawrence Janeway, curator of the Chico State University Herbarium; the training was sponsored by the Klamath Network I&M Program. At this training, field crew members were provided with a list of rare aquatic species known from areas in, and adjacent to, the park. As references we used field manuals by Vernon H. Oswald of CSU Chico and a potential rare aquatic species list prepared by Lawrence Janeway.
Target species included: *Potamogeton praelongus, Rhynchospora alba, Scheuchzeria palustris, Scirpus subterminalis, Carex limosa, Carex lasiocarpa, Drosera angelica, Drosera* x *obovata, Lycopus uniflorus, Marsilea oligospora, Sparganium natans.*

The field inventory session lasted from 7/23 - 8/4/03. During this time, field crews visited 20 lakes and ponds that had been determined by the park botanist to contain potential aquatic plant habitat (littoral emergent vegetation) through aerial photography. At these lakes, we performed targeted searches, usually by wading in 30 to 60 cm of water along the lake perimeter and navigating through wetland areas. Targeted searches were also performed at several submergent and emergent wetlands, wet meadows, and riparian areas in the park.

From 8/20 to 9/03, seven wetland sites were visited or revisited: Lake 508, Lake 632, Lake 650, Lake 674, Horseshoe Lake, Twin Meadows, and Grassy Swale.

Crater Lake National Park

After consultation with park staff, two main habitats were determined to be candidate areas for survey. One habitat was the rocky, pumice slopes near the caldera rim. The target species there were *Botrychium pumicola* and *Arabis suffrutescens var. horizontalis.* The other habitat was mid elevation springs, seeps and riparian areas. The target species there were *Mimulus jepsonii* and *Collomia mazama.* Both of these habitats were more conducive to targeted surveys, rather than the transect/belt method, due to their small size and irregular shape. Thus, the crew employed two targeted surveys in pumice slope habitat and 5 targeted surveys in riparian type habitat. Inventories were carried out from 8/4-8/7/03 and 8/19-8/24/03.

RESULTS AND RECOMMENDATIONS

Whiskeytown National Recreation Area

Rare plants were found at some, but not all, of the existing historic sites in the park. We recorded populations of *Allium sanbornii* var. *sanbornii, Trillium ovatum* ssp. *oettingeri, Sambucus mexicana,* and *Arnica venosa.* Voucher specimens, a series of waypoints or a track defining population size, digital images, and data forms were recorded for each of these sites, except the population of *Sambucus mexicana,* which had been previously documented and mapped. The *Arnica venosa* population appeared to be larger than noted in past monitoring efforts, suggesting the population is more extensive than was previously known and/or there has been an increase in the population extent over the last few years.

The historic site of *Penstemon purpusii,* on Shasta Bally, was not re-located after 5 hours of searching. An effort to re-locate the site resulted in the collection of *Penstemon newberryi* var. *newberryi*, only. *P. newberryi* var. *newberryi* is a new species to the Whiskeytown plant list. A historic site re-visitation survey was conducted for a population of *Tritileia crocea var. crocea* on 5/6. After 3 hours of searching the population was not relocated. There were still Patches of snow at the site, where County Line Road meets the NW corner of WHIS, and very little herbaceous growth was visible. The location was re-visited again on 7/7 for two hours; *T. crocea var. crocea* was not re-located. Historic populations of *Clarkia virgata* and *Navaretia heteranda* were surveyed for on 5/6 for 2 hours; neither of these historic populations was re-located. The site, 1/4-mile SE of the Tower house, had more standing water than normal. WHIS had an unseasonably wet early May. The above average amount of standing water could explain the non-emergence of the two species. The historic population of *Allium tribracteatum* was re-visited on 7/9; the species was not found after 4 hours of searching the historic site. On the same day, the historic site of *Sagittaria sanfordii* was re-visited; the species was not found after 3 hours and the survey was terminated. Water levels in Whiskeytown Reservoir were exceptionally high and this emergent plant may have been deeply submerged at the time of our visit. The historic site of *Eleocharis parvula*, on Upper Clear Creek, was re-visited on 7/10. Approximately 1 mile of the creek was surveyed in two hours, without sighting *E. parvula*. The habitat description of *E. parvula* was described as moist mud flats. Very little habitat fitting this description was observed by the KLMN staff; the area surveyed was comprised of mostly sand/gravel or bedrock. The historic site of *Clarkia mildrediae* was re-visited on 7/10 after approximately an hour of surveying a population of, the highly variable, *Clarkia purpurea ssp. quadrivulnera* was observed; *C. mildrediae* was not observed.

Recommendations: As mentioned above, WHIS had an unseasonably wet early May in 2003. Therefore, our information about several of the target species is preliminary. Resurveying in a drier year is warranted. Closer monitoring of the *Arnica venosa* population may aid in determining if the population is actually expanding or not. Further survey efforts may be needed to determine if the population of *P. purpusii* on Shasta Bally still exists.

Lava Beds National Monument

Our field inventory at LABE focused primarily on quantitative belt surveys in the major habitat types of the monument (excluding lava flows). Three targeted searches were performed in the park: at Howitzer Point, Valentine Cave and the Caldwell Cave collapse South of Caldwell Butte. Neither survey type yielded any rare plant species or new taxa for the monument. Considering the need to gather quantitative data in the main habitats within the park, our transects were placed in the largest habitat types. These habitats tended to have widespread vegetation types (e.g., sagebrush) with relatively low diversity and few distinctive species. Small microhabitats where rare plants may be more likely to occur were not thoroughly surveyed. Target microhabitats include cave collapses, buttes, ravines, and areas of unique soil types.

Recommendations: *Penstemon cinereus* may not have been in bloom at the time of our inventory. It blooms June-August and we were there late May and early June. We recommend that future surveys be conducted later in the season, or surveillance be employed throughout the summer, to increase the likelihood of encountering the rare species. Future inventories should focus primarily on targeted habitat-specific surveys within the monument. More surveys in less accessible areas such as the west/south west (Mountain Mahogany) habitat of the park as well cave collapses (Heppe Cave) are also recommended. Finally, we recommend taking a closer look at lava flows for potential rare plants. We avoided this habitat, given the ruggedness of the terrain and concern for field crew safety, and an assumption that lava flow habitats do not harbor large numbers of rare plants; the last assumption may be incorrect.

Redwoods National Park

Rare plants found at the Little Bald Hills site included *Sanicula peckiana, Calystegia atriplicifolia* ssp. *buttensis*, *Perideridia gairdneri*, *Iris innominata, Iris tenax* ssp. *klamathensis* (may have been misidentified in field, specimen not collected), *Senecio bolanderi* var. *bolanderi*, *Arnica spathulata* and *Horkelia sericata*. With the exception of *Arnica spathulata,* these plants were known to exist in the area. There were less than 20 plants in the *A. spathulata* population so a voucher specimen was not taken. Instead, a photo voucher was taken, which a park botanist, Andrea Williams, verified. In addition, we located a population of *Gilia capitata* ssp. *capitata,* a sub-species previously unrecorded in the park. A voucher specimen was collected of this plant. Due to the length of time it took to access the LBH, we were only able to survey the highest priority habitat: Jeffrey Pine/Idaho Fescue. Targeted searches were conducted at two serpentine outcrops. The serpentine outcrops harbored species distinct from those found in the Jeffrey pine/ Idaho fescue habitat. We believe these areas have a good potential to harbor flora not previously known to occur in the park. *S. peckiana* was the most abundant (Figure 2) and widely distributed (Figure 3) rare species in the Little Bald Hills area, with over 2000 individuals observed in 20 belts and the plant occurring in 95% of the belts sampled.

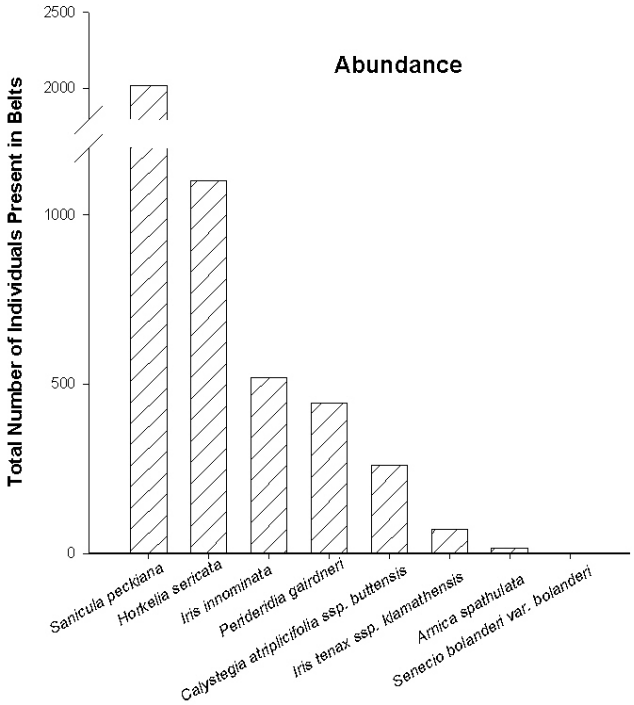

Figure 2. Abundance of rare plant species from the Little Bald Hills transect. The Transect comprised of twenty belts of two lengths. Thirteen belts were 200m by 10m and 50m apart; these belts alternated 240deg.and 60deg., running perpendicular to the transect. Seven belts were 100m by 10m and 200m apart, running at 230 deg.

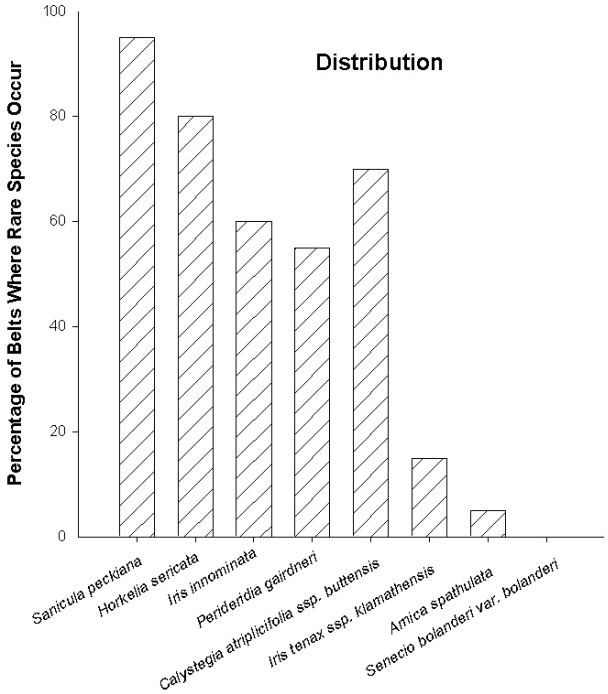

Figure 3. Shows the Distribution of rare plants from the Little Bald Hills transect. The Transect consisted of twenty belts. Thirteen belts were 200m by 10m and 50m apart; these belts alternated 240degrees.and 60degrees., running perpendicular to the transect. Seven belts were 100m by 10m and 200m apart, running at 230 deg.

Rare plants found on the Tracy Property include *Arnica spathulata, Castilleja miniata var. elata, Coptis laciniata (*previously unknown in the park), *Iris innominata, Senecio bolanderi* var. *bolanderi, Calystegia atriplicifolia* ssp. *buttensis, Veratrum insolitum, Pityopus californicus* and *Lillium bolanderi*. *Pityopus californicus* had not been previously observed at the site. Most rare species at the Tracy Property were observed while performing targeted searches; only two rare species were observed in belts Figure 4.

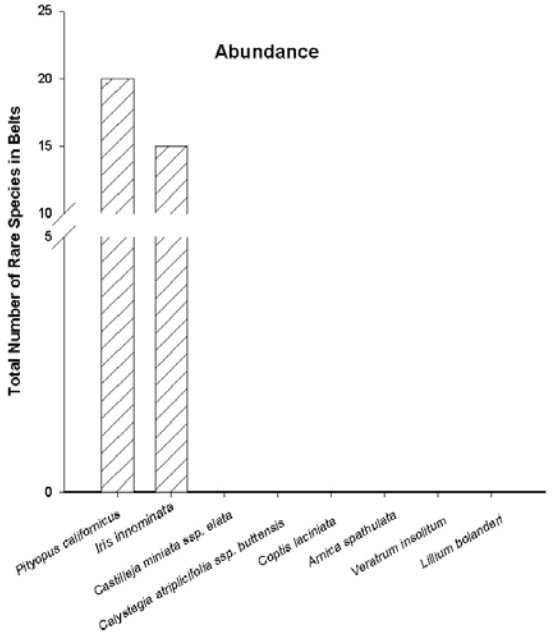

Figure 4. Abundance of rare species observed at the Tracy Property in belts. The nine belts were 100m long by 10m wide and 100m apart and ran at an azimuth of 180deg. Belts began at a random distance perpendicular to the Tracy Property Road.

Recommendations: At the Little Bald Hills a comprehensive search of this area to locate and survey any bogs, rocky outcrops, springs, or riparian areas is recommended. Rare taxa could potentially be observed in such habitats. Targeted surveys of the knobcone pine (*Pinus attenuata*) and the chaparral habitats of the Little Bald Hills are also recommended due to a higher likelihood of locating rare taxa. A target species in the Chaparral habitat would be *Boschniakia hookeri* (*B. strobilacea* is relatively abundant).

Further surveys are recommended to locate more populations of *Pityopus californicus* at the Tracy Property. Because most rare plants are found in local habitats (seeps, outcrops, or other openings) and the dense shrub layer makes extensive survey very difficult, the targeted search method seems best for further survey of the Tracy property.

Oregon Caves National Monument

We discovered two new taxa to the park. These were: *Cardamine nuttalli* var. *covilleana* in the riparian zone of Upper Cave Creek and *Linanthus ciliatus* on a south-facing granite outcrop near the south/southwest park boundary. We have already passed out voucher specimens of these 2 species to the monument. *Cardamine nuttalli* var. *covilleana*, was initially identified as *C. breweri* var. *breweri*; the name left with the specimen left at ORCA. The identity of this species is under debate and a rhizome or tuber needs to be collected to resolve the conflict; either way a new species/sub-species for the park will be the result (L. Janeway, California State Chico, Pers. Com.).

Table 2. Where targeted surveys were done, the time expended, and the rare plant species of interest observed.

Habitat visited	***Date***	***Time Spent***	***Rare/new Species found***
Upper Cave Creek	6/25/03	3 hrs.	*Cardamine nuttalli* var. *covilleana*
Big tree drainage	6/24/03	3 hrs.	------
Big tree trail	6/24/03	1.5 hrs.	------
Granite outcrop (south/southwest section)	6/25/03	4 hrs.	*Linanthus ciliatus*
Shale outcrop (west section)	6/26/03	4 hrs.	---------

Recommendations: A revisit (in late May or early June and then again in late summer) to the granite outcrops (where the *Linanthus* was found) in the south/southwest section of the park is recommended because this area was not thoroughly surveyed due to time constraints. In addition, a more intensive survey of the shale outcrops in the western section (near park boundary) is recommended. This area was thoroughly surveyed but many plant species were already seeding or had died back. Thus, a survey a few weeks earlier in the season may yield more results.

Lassen Volcanic National Park

Carex aquatilus var. aquatilus was observed in the east meadow of Horseshoe Lake, near the ranger cabin; this is a new species for the park. *Rhynchospora alba*, another new species, was also collected at Little Willow lake during the training at the start of the inventory. All lakes and ponds in Table 3 below were thoroughly surveyed within the time span noted. The phenological readiness and diversity of vegetation, as well as lake size determined the time that we chose to spend at each location. Due to late lying snow and cool spring temperatures, many plant species had yet to emerge at the time of inventory, making field identification difficult. Nonetheless, our inventory suggested that the east meadow of Horseshow Lake has medium to high potential habitat for regionally rare peatland-associated graminoids.

No target species were found at any of the seven sites visited in the late August survey. However, *Sisyrinchium elmeri*, a species not previously recorded in the park, was found at Grassy Swale. A bur-reed (*Sparganium sp.)* was found at Lake 632, but was not yet flowering. A bur-reed population at Horseshoe Lake was determined to be *S. angustifolium*, not the listed *S. natans*.

Recommendations: More extensive surveys are warranted in those lakes listed below that have a potential of medium or high for harboring rare aquatic species. As noted above, the

field crews and park botanist concluded that most of this inventory occurred a few weeks too early for phenological readiness, especially in the higher elevation meadows. Further surveys may be more effective later in the season or in a more typical snow year.

Table 3 This table shows the lakes we surveyed during our field session at LAVO, time spent at each location, and any rare/previously unknown species that were found. We also assessed the potential for rare species at each lake. The potential ranking was based on amount and diversity of emergent and submergent vegetation present. A high potential ranking was given to lakes with a high amount (>50% cover) and diversity (>25 species observed) of plant species. These lakes also had wetland components such as a sphagnum bog or wet meadow, which added diverse habitat. A medium potential ranking was given to lakes with some littoral vegetation (20-50% cover) and a moderate diversity (10-25 species) of vegetation. A low potential ranking was given to lakes with little or no littoral vegetation (<20%) and few (<10 species) or plant species.

Lakes visited	*Date*	*Time spent*	*Rare/previously unk. species found*	*Potential*
Lake 632	8/20/03	N/A	-	Medium
Lake 650	7/23/03	50 min.	-	Medium
	8/20/03	N/A	-	
Lake 661	7/23/03	30 min.	-	Low
Lake 649	7/23/03	20 min.	-	Low
Lake 632	7/23/03	50 min.	-	Medium
Lake 674	7/23/03	15 min.	-	Low
	8/20/03	N/A	-	
Horseshoe Lake/Meadows	7/24/03& 8/3/03	11 hrs.	*Carex aquatilis* var. *aquatilis*	Medium-High
	8/27/03	N/A		
	8/29/03	N/A		
Twin meadows	7/27/03	2 hrs	-	Medium
Hemlock	8/1/03	30 min.	-	Low
Sifford	8/1/03	2 hrs	-	Low-med.
Lake 508	8/2/03	2 hrs	-	High
	8/29/03	N/A		
Lake 517	8/2/03	30 min.	-	Low
Lake 550	8/2/03	50 min.	-	Medium
Lake 548	8/2/03	30 min.	-	Low
Lake 540	8/2/03	30 min.	-	Low
Lake 506	8/3/03	1 hr.	-	Medium
Lake 512	8/3/03	50 min.	-	Medium
Drake Lake	7/26/03	30 min.	-	Medium
Juniper pond	7/23/03	45 min.	-	Low
Grassy Swale	9/3/03	N/A	-*Sisyrinchium elmeri*	Medium

Crater Lake National Park

Three rare species were found at the park, *Collomia mazama, Carex simulata,* and *Carex crawfordii*. *C. mazama* was found in bloom at a known site, Dutton Creek/PCT, southwest of the rim. At this site, a rare bryophyte, *Schistostega pennata*, was found. This was an exciting discovery since the southernmost known location for this that taxon in the Pacific Northwest is Diamond Lake, Oregon (Dr. Steven Jessup, Southern Oregon University). *Collomia mazama* was also found along the Crater Loop trail in the northwest section of the park near the Sphagnum bog. *Carex crawfordii* was observed at Spruce Lake, a known site, on the west park boundary. In the future this population should be monitored. The habitat is being threatened by the non-native plants *Potentilla norvegica* (Norwegian Cinquefoil), *Verbascum thapsus* (Mullein) and *Cirsium vulgare* (Bull thistle); all of these species are growing alongside *C. crawfordii*. *Carex simulata* was found at Thousand Springs; it was previously known to exist only at Sphagnum Bog. At Sphagnum bog, *Drosera* x *obovata* was found. *D.* x *obovata* is not on Zika's plant list (Zika 2003) for the park. *Arenaria aculeate* was found on Dutton Ridge; this may be a new species for the park. Zika's plant list notes *A. aculeate* as being very similar to *Arenaria pumicola* a known species in the park. *A. aculeate* was found in the same location *Arenaria pumicola* was found. The two specimens should be compared for better identification. *Carex integra*, a new species for the park, was found east of Poison meadows near the junction of the Pacific Crest Trail and the South fork of Bybee Creek.

Table 4. Where targeted surveys were done, the time expended, and the rare plant species of interest observed in CRLA.

Habitat Visited	***Date***	***Time Spent***	***Rare/New Species Found***
Dutton Ridge (Westside)	8/19/03	5 hrs.	----------
Dutton Ridge	8/22/03	6 hrs.	*Arenaria aculeate*
Boundary Springs	8/20/03	7 hrs.	-------
Thousand Springs	8/21/03	7.5 hrs.	*Carex simulata*
Dutton Creek	8/23/03	3 hrs.	*Collomia mazama* *Schistostega pennata*
Sphagnum Bog	8/7/03 8/24/03	6 hrs. 2.5 hrs.	*Drosera* x *obovata* *Collomia mazama*
Spruce Lake	8/6/03	5 hrs.	*Carex crawfordii*
(east of) Poison Meadows	8/05/03	8 hrs.	*Carex integra*
Oasis Spring, Middle Fork National Creek	8/24/03	3 hrs.	---------
Crater Springs, Crater Creek	8/24/03	1.5 hrs.	---------
Trapper Creek	8/23/03	2 hrs.	------
Little Castle Creek	8/23/03	1.5 hrs.	------

Recommendations: A targeted survey of the Sphagnum Bog area for *Drosera* x *obovata* is recommended. *D.* x *obovata* is a cross between *D. anglica* and *D. rotundifolia*, both of these species have been documented at Sphagnum Bog. Re-verification of *Arenaria aculeate* is recommended to differentiate it from *Arenaria pumicola*. We believe the inventory may have been too late for *Botrychium pumicola* since a park scientist (Wendy Coleman) had visited one of the known sites 3 weeks prior to our visit and observed the plants at their peak. Thus, a targeted survey of Dutton Ridge occurring within the small temporal window for this species is highly recommended. Typical *B. pumicola* habitat was also observed along the rim and on open pumice slopes on the ridge below the rim. Other sites to survey for this species include Dyar Rock, Hillman Peak, and the pumice slopes southwest of Castle Rock. Additional surveys for rare aquatic plants at Whitehorse Ponds and Quillwort pond may prove worthwhile. The moist west portion of the park, from the western boundary to the PCT is excellent *Carex* habitat. The area is difficult to access, but further trips to the Bybee Creek riparian area could produce more new species, as it did in this inventory.

Lastly, since we did not perform any quantitative searches in this park, implementing transects in large habitats in this park may offer some insight to distribution and abundance of rare taxa on a park-wide scale.

CONCLUSIONS

In this 5 month field inventory with a two person field crew, we were forced to move quickly from park to park and to spend relatively short time periods in each park. Nonetheless, we located new species in several of the parks and new plant populations in several other parks. The fact that we located new species and rare plant populations in such a modest survey effort suggests that there is definitely floristic biodiversity remaining undocumented in the Klamath Network parks. Further inventory is warranted if future funding sources can be located. Quantitative belt samples were not very efficient in capturing new species for the parks, but were valuable in illustrating the distribution and abundance of species in habitats where they are relatively common (e.g., Little Bald Hills in REDW). Given the limited money that is available for basic inventory, we recommend basic targeted searches as the preferred approach for locating new species. Rare plants were non-randomly distributed in the parks and showed strong affinities with distinctive habitats, such as rocky outcrops (especially of unusual parent materials, such as serpentine), seep wetlands, riparian zones, sphagnum peatlands, talus slopes, and meadow margins. More detailed and extensive sampling of such habitats is likely to yield both new populations of known rare species and new species to each park. Quantitative sampling should be employed to ensure broader coverage, for rare plants that are scattered through the more extensive habitats of the parks.

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Appendix 1. Klamath Netowork Site information form.

Site Information Form

Park: | **Date:** | **Time:** | **SampleRecordID:**

Crew:

WxCloudCover: C P O | **WxPrecip:** | **WxWind:** C L G S | **WxTempAir:**

WxRelHumidity: | **WxTempSoil:**

EncounterClass (circle one)

Survey Plot(polygon) Time-Constrained Search Transect Survey(line) Point Site(point) Incidental Sighting

Other (explain):

StratumClass1:_____ **StratumClass:2**_____ **StratumClass:3**_____

StratumClass:4_____ **StratumClass:5**_____ **StratumClass:6**_____

UTM_Zone: | **UTM_Datum:** | **UTM_Error:** | **UTMcorrected:** Y N

UTM_E: | **UTM_N:**

Quad_Township: | **Quad_Range:** | **Quad_Section:** | **Quad_1/4:**

Description to Site: _____

PlotShape:_____ PlotLength:_____ PlotWidth:_____ PlotRadius:_____ PlotOther:_____

Elevation: **Slope:** **Aspect:** **%SurfaceWater:**

Topography (circle one)

Level ToeSlope LowerSlope MidSlope UpperSlope Escarpment/Face Ledge Crest Depression Draw

SlopeShape (circle one)

Concave/Concave Concave/Straight Concave/Convex Straight/Straight Straight/Convex Convex/Concave Convex/Straight Convex/Convex

Hydrology (circle one)

FloodedPermanently SemiPermanently Seasonally/Temp Intermittently Seep Upland

Ground Cover (should sum to 100%)

BedrockBoulder: | **GravelCobble:** | **SandSoil:** | **Talus:**

HerbsForbs: | **GrassLitter:** | **Mosses:** | **Ferns:**

LeafLitter: | **WoodyDebris:** | **Lichen:**

Cover Classes 1:<1% 2:1-5% 3:5-25% 4:25-50% 5:50-100%

Descrip_GeneralSite: _____

Site Vegetation

Leaf Phenology (of uppermost stratum having >10% cover)

TreesShrubs: Evergreen _____ Deciduous _____ Mix (Evergreen/Deciduous) _____

Herbs: Annual _____ Perennial _____ Unknown _____

Physiognomic Class (circle one)

Forest Woodland SparseWoodland Shrubland SparseShrubland Herbaceous SparseVegetation

Vegetation Strata

	Height Class	% Cover	3 most Dominate Species in each Category
Canopy:	1 2 3 4 5 6	A B C D	
SubCanopy:	1 2 3 4 5 6	A B C D	
Shrub:	1 2 3 4 5 6	A B C D	
Herb:	1 2 3 4 5 6	A B C D	

Vegetation Descrip: _____

General Comments: _____

Map: Y/N **Image:** Y/N **Sketch:** Y/N

SKETCH AREA

Appendix 2. Rare plant species mapping form

Rare Plants Mapping Form - KLMN

ParkCode*		**Date***	/ /	**LocationID***	
StartTime*		**EndTime***		**EventID***	
CrewName*				**Sketch***	Yes No

SpeciesCode*	**% Cover***	**Image Taken?**	**Distribution**	**Number of plants in Area***
	O R U C A	Yes No	CL SP SE LI	
Phenology*	**Lifeform***	**Plts Flowering**	**Gross Area**	**Population Area***
G1 G2 G3 G4 RG F1 F2 F3 F4	AL FB FU GR LC LI NP SH SS TR UN VI			
		Comments		

SpeciesCode*	**% Cover***	**Image Taken?**	**Distribution**	**Number of plants in Area***
	O R U C A	Yes No	CL SP SE LI	
Phenology*	**Lifeform***	**Plts Flowering**	**Gross Area**	**Population Area***
G1 G2 G3 G4 RG F1 F2 F3 F4	AL FB FU GR LC LI NP SH SS TR UN VI			
		Comments		

SpeciesCode*	**% Cover***	**Image Taken?**	**Distribution**	**Number of plants in Area***
	O R U C A	Yes No	CL SP SE LI	
Phenology*	**Lifeform***	**Plts Flowering**	**Gross Area**	**Population Area***
G1 G2 G3 G4 RG F1 F2 F3 F4	AL FB FU GR LC LI NP SH SS TR UN VI			
		Comments		

All Field with an * are required!

SKETCH AREA

Appendix 3.Rare Plant Transect Form.

Rare Transect Form - KLMN

ParkCode		Date	/ /	LocationID	
Start Time		End Time		EventID	
Crew Initials					
Belt Length		Belt Width		SubUnit#	

Point Distance 1	Overstory Cover Estimate 1			
	Open	Closed	Disturbance Estimate 1	Slope Estimate 1
			O R U C A	

Point Distance 2	Overstory Cover Estimate 2			
	Open	Closed	Disturbance Estimate 2	Slope Estimate 2
			O R U C A	

Point Distance 3	Overstory Cover Estimate 3			
	Open	Closed	Disturbance Estimate 3	Slope Estimate 3
			O R U C A	

SpeciesCode	% Cover	Comments	Plant Number
	O R U C A		
	O R U C A		
	O R U C A		
	O R U C A		
	O R U C A		
	O R U C A		
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	O R U C A		

All fields within this form are REQUIRED
O=<1% R=1-5% U=5-25% C=25-50% A=>50%

SKETCH AREA